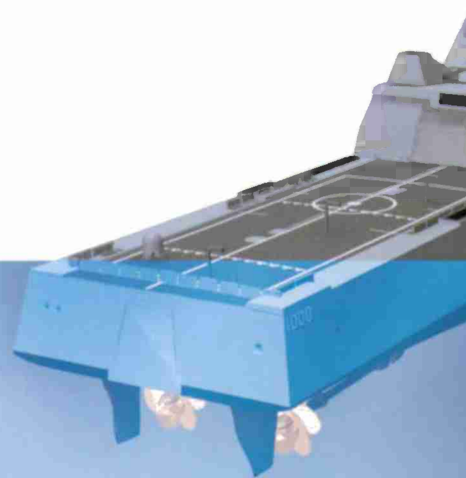
DEFENSE STANDARDIZATION PROGRAM

CASE STUDY

Common Parts Catalog for Industry Shipyards

20121207048

Distribution Statement A.
Approved for public release;
distribution is unlimited.



This case describes how four industry shipyards and the Navy collaborated to develop a Common Parts Catalog (CPC)—a tool that uses catalog management techniques to promote parts standardization and management through data sharing—to dramatically reduce inventory, design, engineering, and life-cycle costs across the U.S. marine industry.

Common Parts Catalog for Industry Shipyards

BACKGROUND

The CPC is a powerful tool for enabling standardization in shipbuilding. It builds upon a legacy of successful standardization in ship and submarine construction. The opportunity for standardizing and streamlining parts management was clearly demonstrated by the results of part standardization and reuse in surface ships and submarines. A success story for submarines was documented in an earlier DSP case study, *The* Virginia *Class Submarine Program*, available on the DSP website (http://www.dsp.dla.mil). That case study illustrates the power of standardization and the millions of dollars that can be saved through focused and disciplined standardization. The accomplishments documented in *The* Virginia *Class Submarine Program* case study provided a solid foundation and a framework for the creation of a CPC for industry shipyards.

The CPC also has roots in an earlier achievement of significance, the hull mechanical and electrical equipment (HM&E) standardization program. The HM&E program's success is documented in another DSP case study and is also available on the DSP website. In the 1980s, the Navy began examining the proliferation of HM&E equipment. That effort dramatically reduced the unnecessary introduction of new HM&E equipment in the fleet. The HM&E standardization effort developed a new tool for standardizing equipment, the HM&E Equipment Data Research System (HEDRS), a collection of databases and analytical programs. With HEDRS, the planning, design, engineering, operations, maintenance, and logistics communities could research equipment and greatly improve standardization across the fleet. In many ways, the HM&E program pilot tested the way for greater standardization at shipyards.

The Navy also achieved outstanding standardization results through disciplined standardization pro-

grams on the submarine classes constructed after the *Seawolf* class was discontinued due to cost overruns. In *Seawolf*, part proliferation was a significant problem, and many duplicate part numbers were created by the multiple shipyards. The *Virginia* class cost less in part due to deliberate standardization and by using commercial off-the-shelf (COTS) components, especially for computers and data networks.

The *Virginia* class employed a formalized part standardization program at the start of the detail design phase to prevent the part proliferation experienced in the earlier class. The standardization efforts dramatically reduced the numbers of parts required and achieved significant cost avoidance. The program established an empowered Part Standardization Board, used formal standardization criteria, and created a database architecture that promoted parts discipline and standard part reuse within the design development process. These outcomes clearly demonstrated the value of parts standardization across shipyards' design, construction, and maintenance activities.

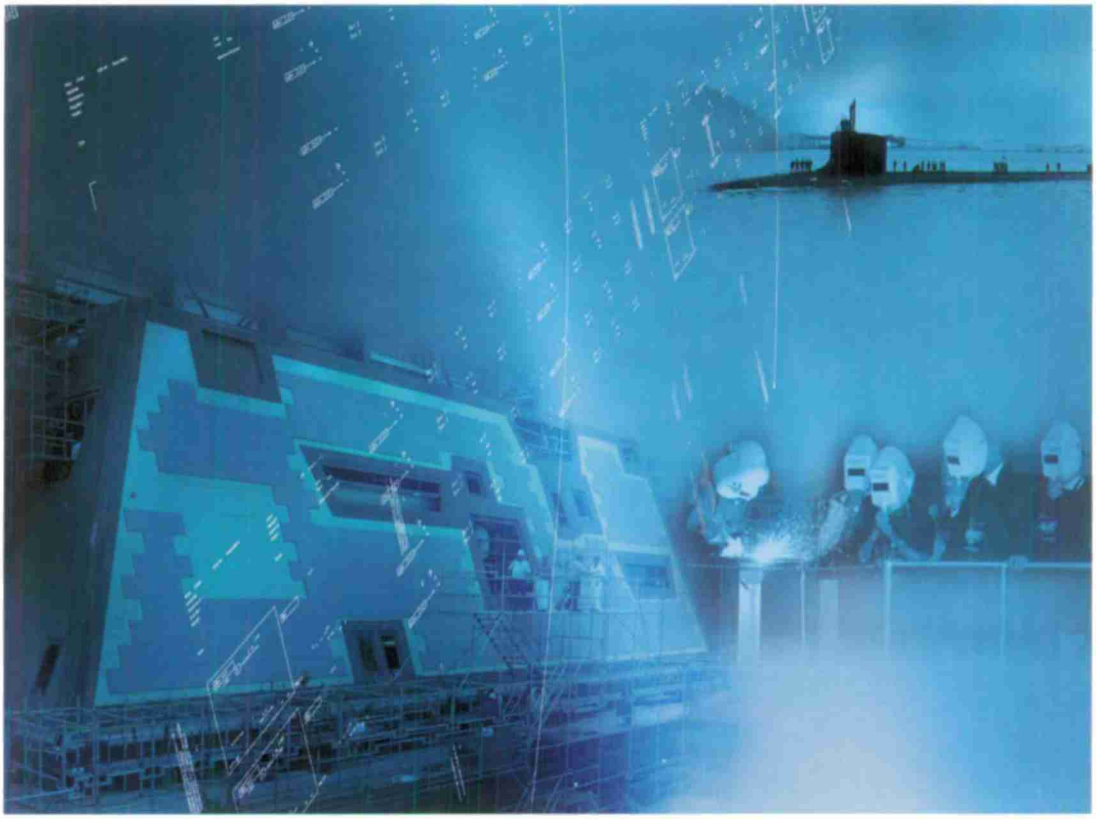
In 2003, the National Shipbuilding Research Program (NSRP) sponsored a project to standardize and classify the methods of catalog construction and administration, with the goals of reducing the number of unique parts and eliminating the needless replication of part data. The project, a collaboration among four first-tier commercial naval shipyards, developed a CPC database, with standards and procedures for consolidating shipyard part data in a single shared resource. The CPC enables better utilization of resources, streamlines the process of cataloging parts and material, and facilitates direct interaction among the shipyards' catalog systems. The NSRP is a cost-sharing, collaborative, shipbuilding technology research consortium of 12 shipyards, the Navy, and the U.S. Coast Guard, whose aim is to reduce the cost of ship acquisition and repair. The consortium focuses on common cost drivers and inherently multiyard, multiprogram problems. The NSRP framework efficiently coordinates collaborative research and development among all segments of the ship construction and repair enterprise to reduce the cost and time required for Navy and commercial ship construction, conversion, and repair. Nearly 150 entities from 34 states have collaborated on NSRP-funded activities.

Problem

A common problem in industry, including the shipbuilding industry, has been the lack of standardization in parts catalogs. The industry lacked a standardized method for representing and communicating information about product characteristics without ambiguity or redundancy. This resulted in large, nonstandard catalog systems that made it difficult to search for and reuse parts. Over time, when existing parts could not be easily located, duplicate parts were created, perpetuating and exacerbating the cataloging problems. The *Seawolf* part proliferation scenario proved that many duplicate part numbers are created (as many as 10) during a new class design when part standards and criteria are not established, monitored, and enforced.

Shipyards employed outdated control systems for tracking and monitoring parts within shipyard cataloging systems. Legacy parts catalogs used outdated customized, rather than COTS, software; had inadequate user interfaces; provided poor support for queries and analyses; were unsuitable for integration with computer-aided design (CAD), product data management, planning, and procurement systems; and had inadequate linkage to specifications and other technical and contractual documentation. Other issues with the legacy parts catalogs included their inability to support Integrated Product Data Environment (IPDE) initiatives or part equivalency between shipyards and their minimal ability to support part searches, standardize data, or share or transmit part data for reuse by shipyards, customers, or entities in the supply chain.

Shipyards experienced part proliferation, difficulty in finding appropriate substitute parts, barriers to teaming and collaboration, too many suppliers and small order quantities, excess inventory in storage and handling, and invisible surplus material. The impact was compounded at the industry level, limiting collaboration, workload sharing, and surge capability. Shipyards had no standard ways to communicate about parts procurement, use, and inventories. Vendors had no standardized format for delivering part functionality information to shipyards, so similar components were often described



in several different ways. The results were long acquisition lead-times and design rework. In short, the shipyards' legacy parts catalogs had limited or inadequate capability to support marked improvements in these areas and was the primary reason to develop a CPC.

Approach

With funding from NSRP, the CPC project teamed Electric Boat in Connecticut, Bath Iron Works in Maine, Ingalls Shipyard in Mississippi, and Avondale Shipyard in Louisiana. (Electric Boat and Bath Iron Works are part of General Dynamics Marine Systems Group, and Ingalls and Avondale were part of Northrop Grumman Ship Systems.) Three support contractor organizations were also involved: i2 Technologies (a provider of supply chain solutions subsequently acquired by JDA Software Group), Computer Sciences Corporation, and Ingalls IT. Together, the seven entities developed the collaborative CPC database system. They adopted industry best practices and innovations in parts management to advance parts commonality, equivalency, standardization, and data configuration management.

Key Teams

Three key teams were formed:

- *CPC project team.* The team consisted of five to eight full-time individuals—managers, material engineers, and catalog personnel with experience in project management, cataloging, and software engineering—from each participating shipyard. This group had overall responsibility for designing and implementing the CPC. The resulting CPC is a state-of-the-art relational database populated with detailed part-related data. The team created a structured data model architecture, data models, a data dictionary, and detailed procedures for adding and maintaining data in the CPC.
- *Central Configuration Control Group (CCCG).* The CCCG consisted of one or more representatives from each participating shipyard. This group functioned as a single authority to ensure consistent, continuing, and structured communication among the shipyards regarding catalog data, data models, and operating systems. The participating shipyards developed agreements defining the objectives, project management, and bylaws for the CCCG and identified the processes required to develop, format, issue, and revise data to ensure and maintain data integrity. The group ensured that the shipyards acted as one while not adversely affecting day-to-day business activities at each shipyard. The group also ensured that data integrity was maintained by enforcing procedures to maintain part and system configuration across the shipyards. In addition, it audited the participating shipyards to ensure compliance with standardized processes.
- *Executive Steering Committee (ESC).* The ESC, like the CCCG, consisted of one or more management representatives from each participating shipyard. The ESC served as the project sponsor,

providing guidance, support, and resources as required.

Project Management

After receiving the NSRP contract in 2003, the CPC project team held kickoff meetings at each shipyard to ensure project management synergy. The team developed shared objectives and a detailed integrated project plan. Software was selected and successfully installed at four shipyards. The CPC exists in two identical and connected environments, one in Mississippi, supporting Huntington Ingalls Industries–Ingalls Shipbuilding and Avondale, and the other in Connecticut, supporting Bath Iron Works and Electric Boat. This enables multicorporate part standardization and data sharing. The two environments are maintained to ensure compatibility and are linked in real time by a dedicated line to ensure synchronization and continuous data flow, as well as to provide full redundancy and backup capability.

The CPC interfaces with the shipyards' individual legacy catalog systems while ensuring that the functionality of those systems was not affected. The team reviewed business processes at all participating shipyards and identified best practices in the areas of part commonality or equivalency, part standardization, and part data configuration management. The team used catalog management techniques from all participating shipyards to provide standardized catalog data to engineering, design, manufacturing, and procurement systems.

The project used milestones within a comprehensive schedule to ensure project objectives and goals were met. The project managers held weekly teleconferences to coordinate activities, identify issues, and track progress on specific schedule-sensitive activities. The project team developed scenarios (use cases) for sharing and for representing parts and associated document information. The scenarios included not only the sharing of part data among internal shipyard applications but also across organizations for collaborative purposes.

The project was implemented in four phases. Requirements and standards definition occurred in phases 1 and 2. Application development and standard data loading occurred in phase 3. Production turnover, part sharing, and equivalency functions took place in phase 4.

Data Model Architecture

The CPC is a single electronic repository for all technical, quality, and document data associated with unique catalog number designations. The CPC contains all technical data attributes required to purchase or manufacture material on the basis of part definition. Configuration management provides the foundation for a part equivalency program. The CPC links catalog part numbers that are technically and contractually interchangeable, and it provides a vehicle for intershipyard part collaboration. The participating shipyard that creates the part is responsible for conformance to the CPC standards relating to interchangeability analysis, as well as for configuration management of the part during its lifetime.

The CPC structures and organizes previously unstructured information for material management and parts definition within a meaningful and systematic taxonomic structure. The data model is a representation of classes of data needed by the companies, valid properties associated with each class of data, and relationships between the classes of data.

Shipyard catalogs intersect in the CPC data model. The architecture supports each shipyard's business needs and supports intrashipyard practices such as part sharing, equivalency, and data standardization. The data model identifies part and document classes and shows their associations with each other. It contains a compilation of the shipyards' procedures, work methods, policies, and contractual requirements.

The data model provides a road map to identify standard parts and document data relationships using part object class and document class attributes. Each participating shipyard adds its own part data following standard procedures and performs research to link part data across the enterprise. The model has 38 different classes of data. Each class contains all relevant attributes plus necessary cross-linking. Several classes describe primary objects, such as a part object, document, national stock number (NSN), environmental legislation, Chemical Abstracts Service (CAS), Allowance Parts List (APL), procurement history, product structure, or

shipyard-specific capabilities. Three of the most important data classes are as follows:

- ***Part object.*** A part object is specific to a catalog number. The part object class has 100+ attributes, some of which apply to all parts (catalog number, name) and others that are specific to mechanical parts (diameter, thickness) or to electrical devices (ohms, volts). The part object contains the primary description of the part number.
- ***Document.*** This class has 20+ attributes, such as document type, document number, and vendor part number. A document may be a specification, drawing, sketch, list, standard, pamphlet, report, technical manual, vendor's drawing, or other information relating to the design, manufacture, material, testing, inspection, or procurement of a catalog number. A document discloses, at a part level, the physical and functional end-product requirements. The CPC includes parts-related documents needed to qualify and describe the parts themselves. Parts documents may be versioned and amended. The association of a part document to a part also designates the ship contract to which a particular version of a part document applies. Specification histories and part audit histories are also represented to support part configuration management. Finally, parts are associated with various supplemental documents, such as life-cycle attributes and environmental legislation.
- ***Shipyard-specific capabilities.*** Shipyard-specific classes have 90+ attributes that describe unique business capabilities required for each participating shipyard to perform on their contractual obligations.

The CPC data model also has mapping classes, which are specifically designed for linking data classes. For example, mapping classes link part objects or documents to related data such as NSN, document identification, revision, applicability, equivalency, audits, environmental legislation, CAS, APL, procurement history, and product structure. Below are the four most important mapping classes:

- ***Part/document applicability.*** This class contains electronic links between catalog numbers and contractually effective documents, specifications, and procurement requirements, and it provides for online, real-time transaction audit trails in support of contractual requirements.
- ***Part equivalency.*** This class provides the capability to identify interchangeability links within and between yard, vendor, and government part numbers and provides intra- and intershipyard part equivalency. Part equivalency is the key to sharing, standardization, and inventory reduction. The project team developed requirements, processes, and procedures to implement and maintain part equivalency. It produced instructions for designating catalog part numbers that are technically and contractually interchangeable, the requirements for maintaining part equivalency, and the criteria used to audit part equivalency. Equivalent parts must pass technical and contractual reviews to determine part

equality and interchangeability. Equivalent parts may be interchanged with no additional approvals. Personnel involved in the part equivalency review represent parts organizations and engineering, quality, and design functions. The focus of the equivalency review is on the technical attributes that determine part equality. The goal is to provide procurement and material control systems with the ability to use equivalent parts information in their associated business processes.

- *NSN.* This class provides an ability to associate one or many NSNs to a single catalog number.
- *Product structure.* This class provides a capability to identify parent-to-child part relationships within a catalog number.

The CPC data model defines relationships between parts and the hierarchical relationships of part category attributes. The project team identified relationships between parts, as well as the mandatory and preferred part attributes at each level. This approach provided standard steps so that resulting replacement data could be easily reused. The data relationship standards are electronically maintained in the data model.

Data Element Dictionary

The CPC data element dictionary is an organized repository of information about data resources; it contains data element specifications, data file structures, and data file maintenance features. The data element dictionary is the control document for definition and data structure and provides a single control for standardization of data elements shared electronically between participating shipyards.

Configuration Management

The controlled use of documents and revisions is an important requirement for CPC configuration management. Managing the configuration of a document or catalog number is the responsibility of the shipyard owning the document or part. Only that shipyard is allowed to update the data. Each shipyard's configuration management procedures must meet CCCG requirements. A revision to a document or part record must be reviewed for its effect on part interchangeability. The CCCG audits the shipyards to ensure conformance to standards.

The system contains processes and procedures for configuration management within and between the participating shipyards. It provides a compilation of the procedures, work methods, and policies that control configuration management of part document data within and across the shipyards. It identifies application rules for the use of government and commercial specifications and standards, design agent and vendor drawings, vendor parts, model types, procurement notes, and all other documents required to be associated to a part object. It provides a standard method to maintain part equivalency for the shipyards.

Configuration Management Audits

The CCCG audits the data being entered into the CPC to assess data integrity for both part and asso-

ciated document attributes. The audits were designed to ensure awareness, among all participating individuals, of functional responsibilities and of the importance of data integrity in supporting business needs.

Excess/Surplus Material

The CPC provides visibility to surplus material that may be available for resale. Indicators of surplus material are electronically updated in the CPC on a regular schedule. The schedule ensures accurate information is available to all participating shipyards.

Enhancements

Since the CPC's implementation, there have been many lessons learned, along with suggested enhancements and advancements in technology. Currently, the CPC is providing part definition processes and disclosure capabilities to the participating shipyards. The CPC is limited to part attribute and document data; it does not capture, exchange, or link three-dimensional (3D) geometry to the part data, a capability desired by both the shipyards and the Navy as a cost-saving enhancement. The engineering data sharing and 3D geometry reuse to support arrangements, layout, and visualization were in the original scope of the CPC but were unattainable due to software and technology limitations.

There are plans to analyze, identify, and map the implementation of enhancements to the existing capability in the following areas:

- *Network, software, and application changes.* This area addresses application upgrades required to provide capability improvements. Business processes also need to be updated to account for new capabilities and facilitate effective data reuse, and where possible, common tools should be used to support the common processes.
- *Model inclusion and exchange.* This area addresses the inclusion or linking of models with CPC parts to support visualization, spatial integration, and reuse of full 3D geometry. Enhancements will include 2D and 3D graphics, including drag-and-drop into CAD sessions.
- *Functionality enhancements.* Potential functionality enhancements are continually examined. Some examples are the inclusion of engineering data, Navy best value data, and catalog numbering systems; development and extension of a common data element dictionary and set of enumerated valid values that support the CPC; review of the system architecture and classification schemes; and development of one set of procurement notes used by all shipyards.

In addition, an NSRP goal is to broaden participation, implementation, and application of the CPC across the U.S. shipbuilding enterprise. Plans include other first-tier shipyards performing an analysis and business case to determine possible expansion of the collaboration. Core capabilities of each participant will be analyzed to determine the degree of change required to adopt CPC processes and tools. Reviews will employ a project development plan that supports the participation of CPC participating shipyards, their information technology and application providers, and potential new partici-

pants, each developing its requirements by examining the current state and then applying best practices and lessons learned to design its desired future state. Each potential new participant will use the data to develop a business case analysis to support the recommendation on becoming a CPC participating shipyard.

CPC Web Service

A web service can be used to provide on-demand access to CPC data to external applications. The data provided by the service consists mainly of vendor or shipyard part data associated with catalog part entries in the CPC. The web service is designed to facilitate the exchange of data between the CPC and external applications that are associated with the most common parts catalog use cases.

The service provides the minimum set of operations that will allow for searching the catalog to create a list of parts that meet a specific set of requirements, for locating and downloading the details of a part entry, and for adding new part entries into the CPC.

Benefits

The improvements made possible by the CPC—enabling sharing of standardized data across company boundaries, a rare occurrence because companies often treat part data as proprietary—have resulted in cost reductions and cost avoidance for the participating shipyards in the areas of part standardization, part equivalency, part configuration management, and data sharing.

Project resources included a set of requirements and standards supporting the catalog needs of the individual shipyards and a software application to manage and store the standard catalog data. The shipyards' best practices and business processes were integrated into the CPC design. The design is scalable and flexible, allowing for growth of data, users, and user sites. The design is flexible enough to enable the CPC to easily interface with other applications such as product data management systems and suppliers' online catalogs. The design also allows for the addition of other shipyards' part data.

The CPC has over 2 million catalog numbers categorized into a standard classification scheme and 7 million configuration-managed document identification numbers linked to the catalog numbers. It

has more than 180,000 intershipyard part equivalency links and supports hundreds of daily shared part transactions between shipyards. Audits identify a 99.9 percent accuracy rate against defined intershipyard standards. A substantial majority of the procured material for the Navy's surface combatants, submarines, and amphibious ships is now standardized and configuration managed in the CPC.

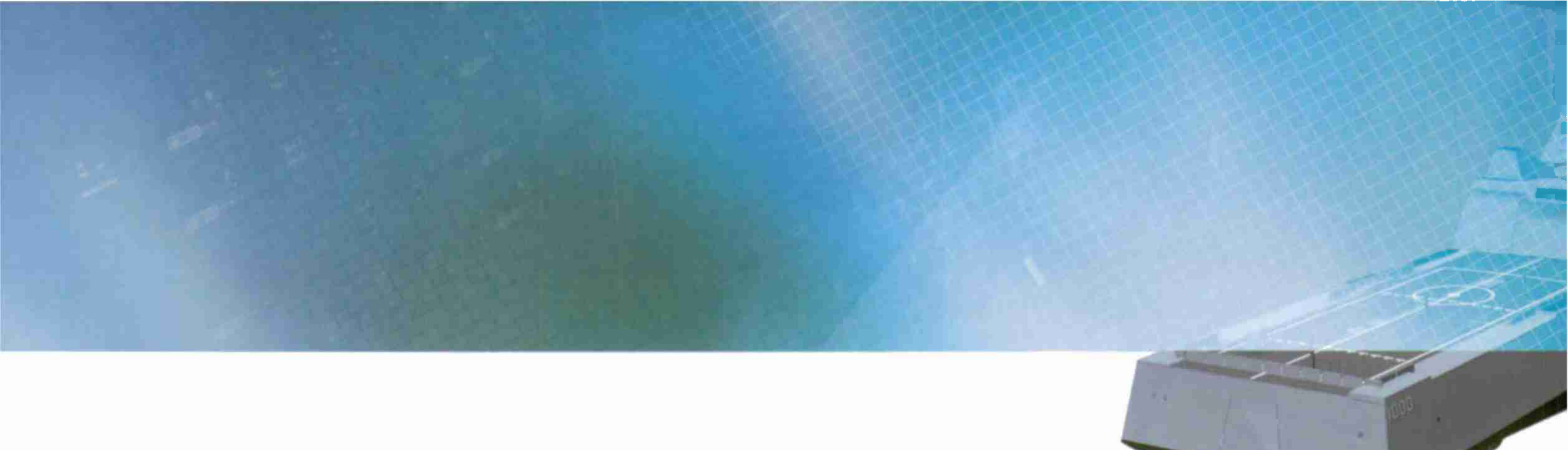
The CPC has enabled faster and more accurate information retrieval. Users can find parts information quickly and easily. Less time is required to find parts and to retrieve vendor or government specifications. The CPC has reduced material searches by an estimated 30 to 50 percent and reduced part-related design and engineering costs by an estimated 10 to 20 percent.

The CPC facilitates the elimination of duplicate part numbers, eliminates the generation of new part numbers for components already in the CPC, and, through the use of a part standardization program, reduces the total number of parts. Fewer parts in the government supply system means less paperwork and a reduction in the number of parts that must be procured, received, handled, inspected, and warehoused. With fewer parts to manage and control, inventory costs have been reduced by an estimated 10 to 20 percent.

The CPC facilitates reuse of standard part data across shipyards by providing more visibility and timely access to the data. It enables better communication regarding part replacement, interchangeability, and applicability. It also enables better communication regarding part data requirements between design yards and shipbuilders. It supports realization of unit volume benefits through joint procurements and reduction of acquisition cost through common parts and equipment. It facilitates grouping of requirements, reductions in the number of purchase orders, increased quantity procurements, and leveraging of volume discounts. It provides an ability to increase material availability and reduce cost with joint procurements. The CPC can substantially reduce material cost and the number of unique parts procured through a part standardization program. It supports the use of standard part data across shipyards, suppliers, and customers. Part data are shared across multiple shipyards, providing standard part data for design, manufacture, and procurement.

Standardization across the shipyards can improve operational readiness of the platforms through greater availability of parts across surface and submarine inventories and reduction in the number of parts required to support ships.

The CPC facilitates part equivalency programs and contains procedures to communicate detailed comparison results to the participating shipyards regarding commercial replacement specifications and deleted or nonmaintained military specifications. The system provides a means to communicate, share, and compare analyses of parts or documents, eliminating the need for individual shipyards to duplicate reviews and providing cost



savings to the shipyards and the Navy customer. It provides a method to minimize part duplication and facilitate part standardization. The CPC supports shipyard IPDE capabilities and provides an ability to support present and future IPDE initiatives.

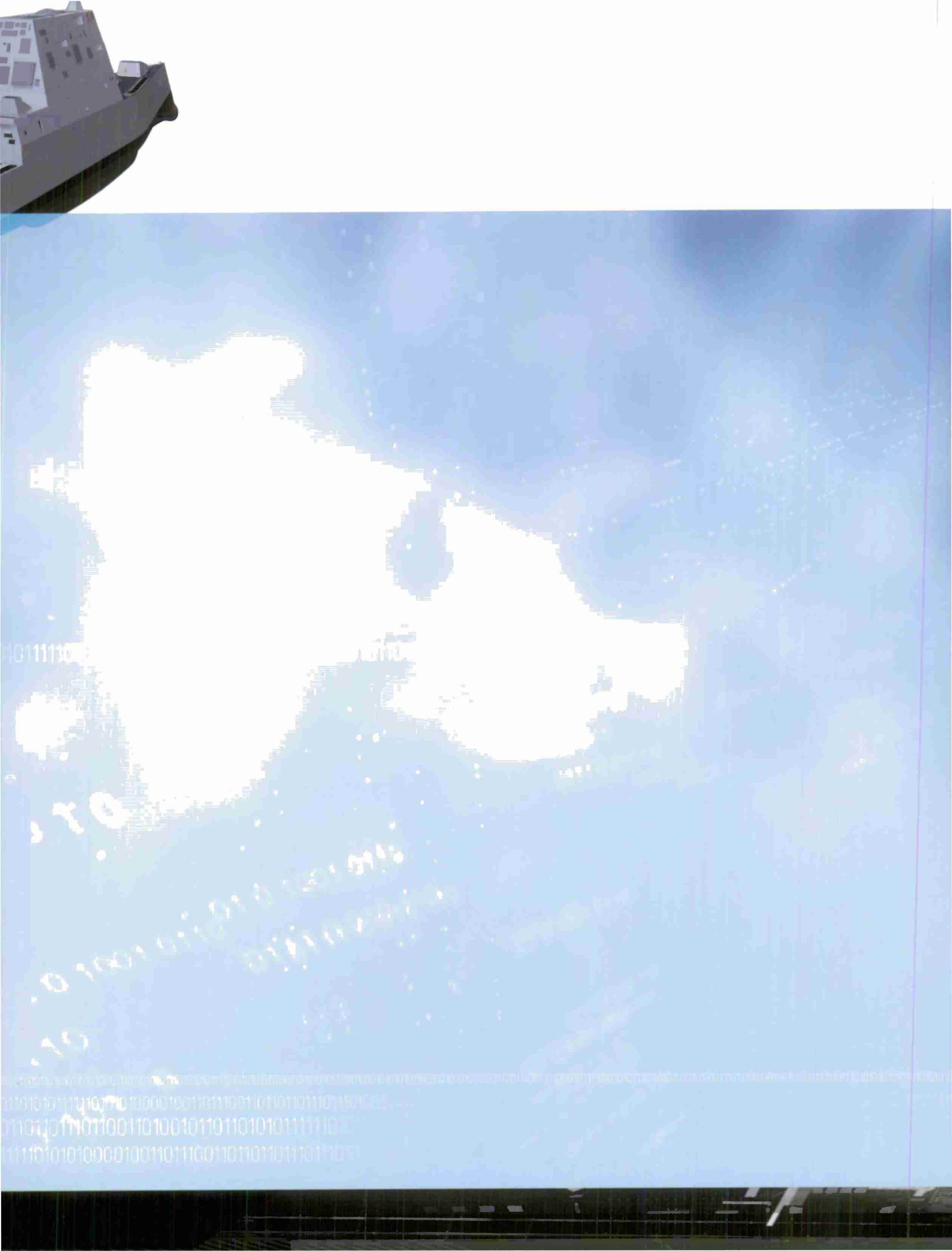
The CPC provides for access to data on critical attributes (e.g., SUBSAFE); to design data, procurement, and quality characteristics; and to shipyard part number cross-references to NSNs. The CPC provides suppliers with electronic exchange of component development data; standardized descriptive and document data; and electronic links between catalog numbers and contractually effective documents, specifications, and procurement requirements. The CPC also provides for online, real-time transaction audit trails.

Lessons Learned

Important lessons learned during the CPC project are as follows:

- Develop a strong business case that is approved and championed by the participating organizations' highest management officials. Develop and document a mutually agreed upon set of requirements. Set up standards early and implement procedural steps to maintain them.
- Create an Executive Steering Committee consisting of senior executives from the participating organizations to act as project sponsors. Meet at least biannually to ensure that all activities are being performed and that standards and procedures are up to date and support company and intercompany objectives.
- Employ strong project managers who promote trust across organizations and develop a team culture of collaboration and compromise. Ensure that converted data conform to the organizations' established standards. Train personnel and repeat training as necessary. Anticipate growth in initial cost and time estimates.
- Set up an intershipyard Central Configuration Control Group with procedures and data audits. Ensure the system is maintained after project completion. Meet at least biannually to ensure all activities are being performed and standards and procedures are up to date. Perform audits to ensure data integrity within and across organizations.

The CPC project team made a commitment to reduce the cost of ships to both government and commercial customers through the implementation of a common parts catalog with associated standard procedures. This required the marine community to examine process improvements to reduce time and related costs in all phases of ship design, construction, and life-cycle support. Shipbuilding enterprise activities can build on the CPC foundation to increase cost savings during design, construction, and life-cycle activities. This project continues to exceed and expand.



DEFENSE STANDARDIZATION PROGRAM OFFICE
8725 John J. Kingman Road, Stop 5100
Fort Belvoir, VA 22060-6220
(703) 767-6888
dsp.dla.mil

For information about the National Shipbuilding Research Program,
contact Ed Gladue

General Dynamics Electric Boat
75 Eastern Point Road
Groton, CT 06340
(860) 433-2568
egladue@gdeb.com